

CR-134131

E-2795

MISSION SL-4 (AS 208/CM 118/IMU 34)

G&N ERROR ANALYSIS

(SKYLAB 4)

by

S. B. HELFANT

October 1973

(NASA-CR-134131) MISSION SL-4 (AS 208/CM
118/IMU 34) G AND N ERROR ANALYSIS
(SKYLAB 4) (Draper (Charles Stark) Lab.,
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The Charles Stark Draper Laboratory, Inc.
Cambridge, Massachusetts 02139

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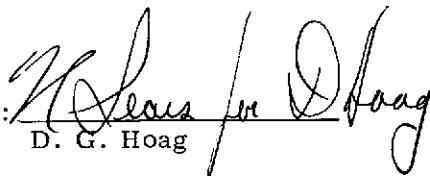
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This volume is the combined effort of the following additional people: Linda Willy prepared the component performance tabulation and performed the plotting for the inertial components. William Beaton provided the failure rates for the success probability. Their contribution to the preparation of this volume is greatly appreciated.

The publication of this report does not constitute approval by the National Aeronautics and Space Administration of the findings or the conclusions contained herein. It is published only for the exchange and stimulation of ideas.

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ABSTRACT

This document presents data on G&N system performance and operation for the CM. For data on the effects of Block II and of measured CM IMU test data deviation uncertainties on earth orbit insertion indication uncertainties and on deorbit burn and reentry uncertainties, the reader is referred to E-2760, the G&N error analysis report for Skylab 2).

by: S.B. Helfant
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GYRO DRIFT TEST POSITIONS
FOR
SUNDANCE, LUMINARY, COLOSSUS, AND ON

STABLE MEMBER POSITION	STABLE MEMBER ORIENTATION	HORIZONTAL DRIFT	VERTICAL DRIFT
1	X DOWN Y SOUTH Z WEST	NBDY-ADOAY	
2	X DOWN Y WEST Z NORTH	+NBDZ-ADOA _Z	-NBDZ+ADIAX
3	X SOUTH Y WEST Z DOWN	NBDX-ADOAX	
4	X EAST Y SOUTH Z DOWN	+NBDY+ADSRAY	+NBDZ+ADIAZ
5*	X WEST Y UP Z NORTH	+NBDZ-ADSRAZ	
6*	X SOUTH Y DOWN Z EAST	+NBDX+ADSRAX	-NBDY+ADIAY
7	X NORTH Y UP-WEST Z UP-EAST	-NBDX+(ADSRAX/ $\sqrt{2}$)	
8	X EAST Y UP-NORTH Z UP-SOUTH	(-NBDZ-NBDY)/ $\sqrt{2}$ +(ADIAZ-ADIAY)/2 +(ADSRAY+ADSRAZ)/2	
9	X UP-EAST Y UP-WEST Z SOUTH	-NBDZ+(ADSRAZ/ $\sqrt{2}$)	
10	X UP-NORTH Y UP-SOUTH Z EAST	(NBDY-NBDX)/ $\sqrt{2}$ +(ADIAY-ADIAX)/2 +ADSRAX/2	
11	X NORTH Y WEST Z UP	-NBDX-ADOAX	
12	X UP Y SOUTH Z EAST	+NBDY+ADOAY	
13	X UP Y EAST Z NORTH	+NBDZ+ADOA _Z	

* Positions 5 and 6 are lab test only.

SKYLAB 4
G&N MISSION RELIABILITY ANALYSIS

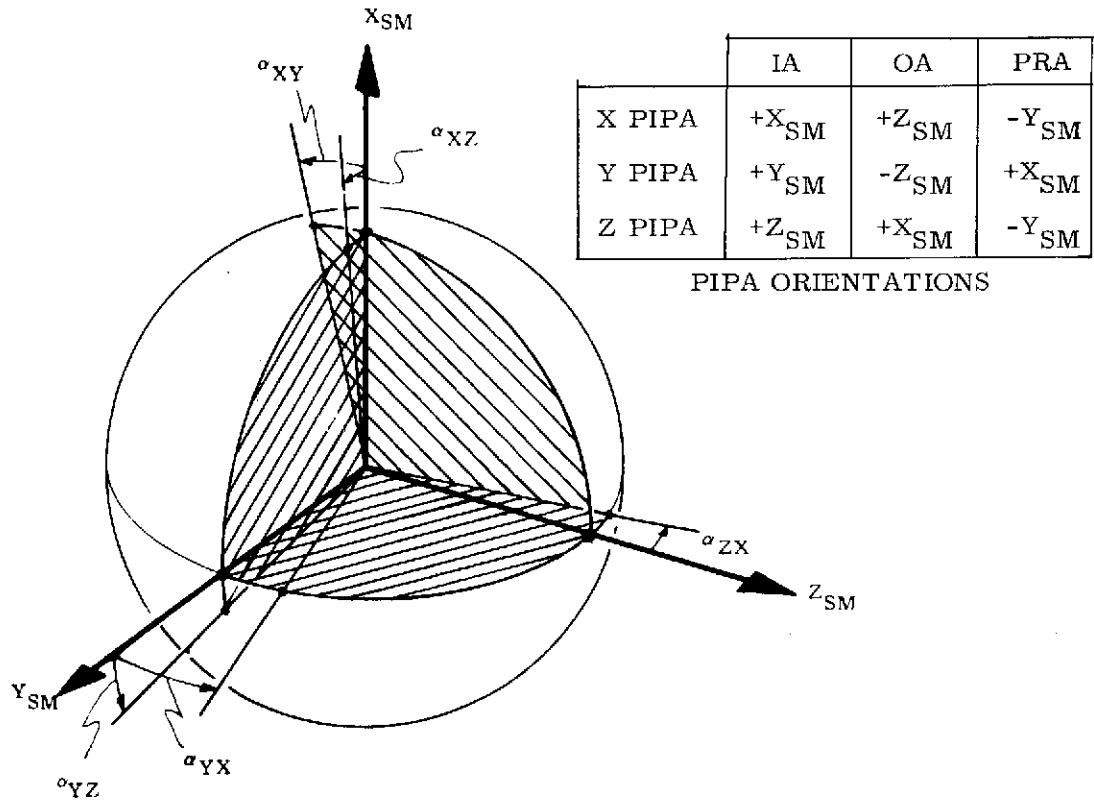
Failure rates used were obtained, for the most part, from observed Apollo field and flight experience of the PGNS. Each reported failure was analyzed with respect to its likelihood of occurrence in flight and the impact on the Mission should such failure occur. The result was to count only those reported failures which could occur in flight and which would degrade the Mission, should they occur.

SUBSYSTEM	MODE (time /cycles)	FAILURE RATE ($\lambda \times 10^6$)	MISSION DURATION (hrs or cycles)	$e^{-\lambda t}$
AGC	Operate	19.2	61	0.99883
	Calendar	2.8	1728	0.99517
	Envirn	30.9	0.45	0.99999
	On/Off	238.1	2	0.99952
DSKY*	Operate	1.4	61	0.99999
	Calendar	0.9	1728	0.99999
	Envirn.	122.9	0.45	0.99999
	On/Off	1190.5	2	0.99999
IMU CDU**	Operate	20.2	61	0.99877
	Calendar	2.4	1728	0.99586
	Envirn	62.5	0.45	0.99997
	On/Off	1666.6	2	0.99667
IMU	Operate	94.1	61	0.99428
	Calendar	2.6	1728	0.99552
	Envirn	18.5	0.45	0.99999
	On/Off	142.9	2	0.99971
IMU Electronics (PSA)	Operate	8.4	61	0.99949
	Calendar	1.2	1728	0.99793
	Envirn	18.5	0.45	0.99999
	On/Off	714.3	2	0.99857
Optics Assembly	Operate	119.3	61	0.99275
	Calendar	1.8	1728	0.99689
	Envirn	18.5	0.45	0.99999
	On/Off	238.1	2	0.99952
Optics Electronics	Operate	17.2	61	0.99895
	Calendar	7.1	1728	0.98781
	Envirn	18.5	0.45	0.99999
	On/Off	142.9	2	0.99971

G&N MISSION RELIABILITY
CM = 0.94712

*Considers parallel redundancy $(1 - (1 - e^{-\lambda t})^2)$

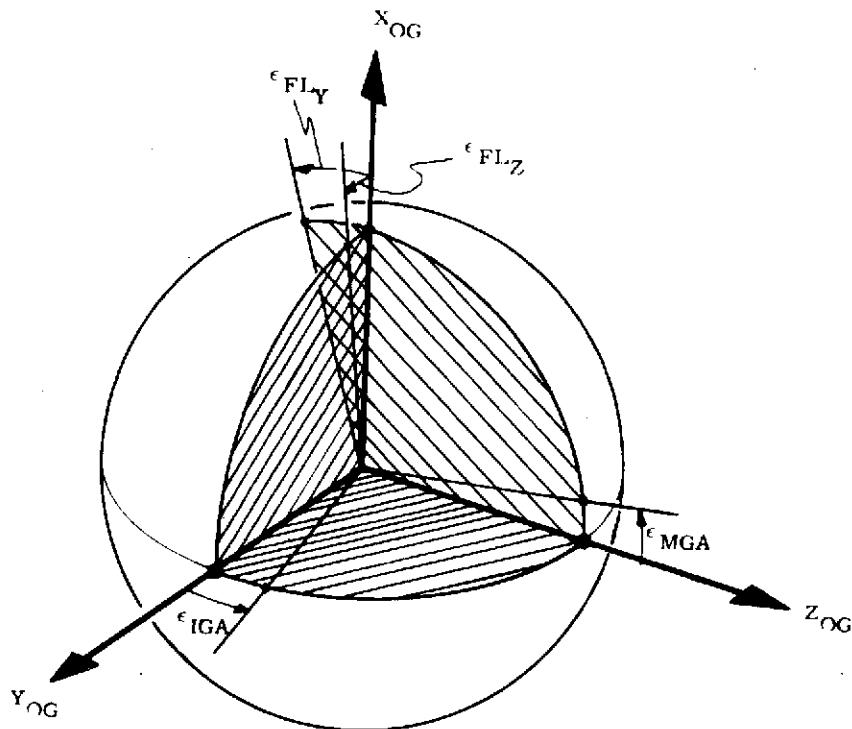
**Includes CM Optics CDU



PIPA Misalignments from Ideal Stable Member Axes

Term	(Angle in Sec)
CM-IMU 34	
α_{XY}	- 7
α_{XZ}	-19
α_{YZ}	+ 5
α_{YX}	+26
α_{ZX}	-17

DEFINITION OF POSITIVE SENSE
 PIPA INPUT-AXIS MISALIGNMENTS
 with respect to
 IDEAL STABLE MEMBER AXES



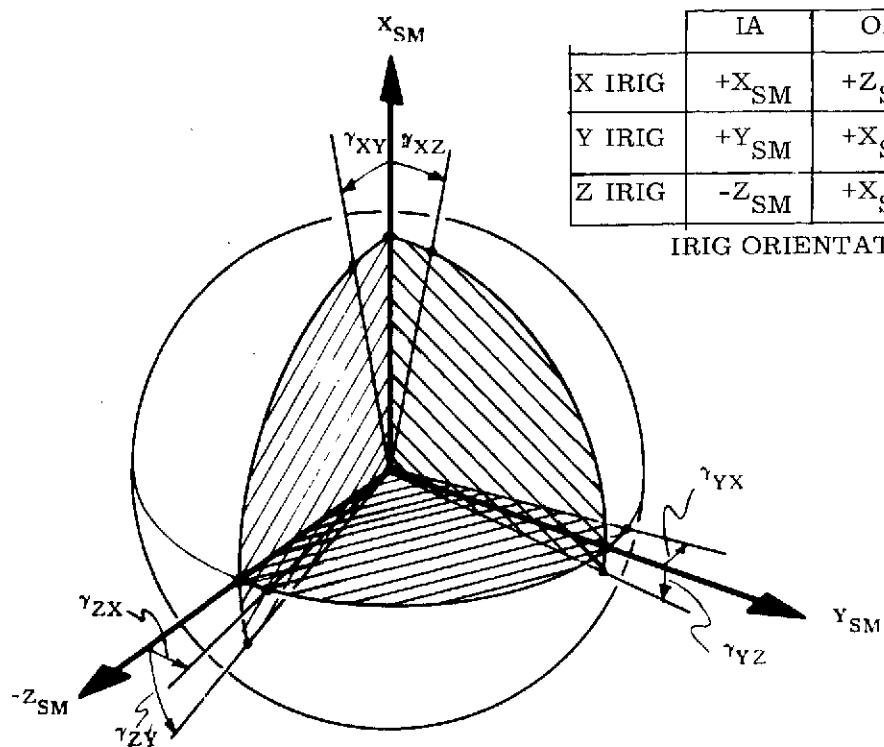
Gimbal Axis Orthogonality Errors and Outer Gimbal Misalignment from Casemounting Axes

Term	(Angle in Sec)
CM-IMU 34	
ϵ_{IGA}	0
ϵ_{MGA}	- 6
ϵ_{FLY}	0
ϵ_{FLZ}	+ 1

DEFINITION OF POSITIVE SENSE
GIMBAL AXIS ORTHOGONALITY
and
OUTER GIMBAL ALIGNMENT
with respect to
CASE MOUNTING ALIGNMENT

	IA	OA	SRA
X IRIG	+ X_{SM}	+ Z_{SM}	- Y_{SM}
Y IRIG	+ Y_{SM}	+ X_{SM}	- Z_{SM}
Z IRIG	- Z_{SM}	+ X_{SM}	- Y_{SM}

IRIG ORIENTATION



IRIG Misalignments from Ideal Stable Member Axes

(Angle in Sec)

Term	CM-IMU 34
γ_{XY}	- 4
γ_{XZ}	- 28
γ_{YZ}	- 8
γ_{YX}	- 22
γ_{ZX}	+ 9
γ_{ZY}	+ 7

Block II G&N
 DEFINITION OF POSITIVE SENSE
 IRIG INPUT-AXIS MISALIGNMENTS
 with respect to
 IDEAL STABLE MEMBER AXES

IMU S/N 34
AS208/CM 118/G&N 222

IRIGs

X = 8A117
Y = 8A102
Z = 8A101

PIPAs

X = 3AP333
Y = 3AP334
Z = 3AP335

NASA SA-117

DATE	TST	TMN	GSM	SYS	NRD	ATSEA	ACTIA	DELSP+	DELSP-	WHEEL	PDT HOURS	I+	I-	ID	ADOA
16AP69	A45	CSS								C107					
16AP69	A45	CSS		(15.3)	(2.6)	(- 2.2)				C 98				11.3	
18AP69	SG	84.6, 70.1, 56.0	TG	55.8, 69.2, 84.6						REF H5218					
22AP69	A44	CSS		(14.1)	(0.3)	(- 3.0)				150				9.7	
29AP69	A44	CSS		(14.5)	(0.4)	(- 0.9)				150				9.8	
1MY69	A44	CSS								153					
5MY69	COMP	SELECT													
5MY69	A44	CSS						-	159	-	120	151	85.002	85.003	
7MY69	COMP	VERIF	S/F	REPADED DUE TO A HIGH IN SPEC.	TW	COUNT									
7MY69	A44	CSS						-	373	-	72		84.997	84.996	
7MY69	COMP	FESSELCT													
7MY69	A44	CSS						321	-	96	155		85.002	85.002	
7MY69	CCMP	REV2RIF													
7MY69	A44	CSS						324	-	55			84.997	84.997	
7MY69	DEMO														
7MY69	A44	CSS						289	-	137	154		84.997	84.998	
8MY69	VIB														
9MY69	EQUIPMENT	MALFUNCTION	-	SERVO	ABORTED										
9MY69	A44	CA1	0.2	3.7	3.4										
9MY69	A44	CA2	0.2	3.6	4.4			106	-	287			84.995	84.995	11.6
9MY69	A44	CA3	0.7	4.0	4.9						156				
12MY69	A44	CB1	1.4	3.2	1.3										
12MY69	A44	CB2	1.5	3.0	- 1.5			176	-	362			84.993	84.994	10.1
12MY69	A44	CB3	1.4	3.0	- 0.5						155				
15MY69	A45	CC1	1.0	3.2	5.4										
15MY69	A45	CC2	0.9	3.1	4.6			31	-	318			85.002	85.001	11.8
15MY69	A45	CC3	1.0	3.0	4.8						158	459			
7AU69	A03	SPO Y 48	0.4	1.9				40	-	351			85.008		1.6
7AU69	A03	SPO Y 48	1.2		- 0.1										
8AU69	A03	SPG Y 48									C114				
8AU69	A03	SPO Y 48									C121				
8AU69	A03	SPO Y 48									C113	518			
3SE69	A03	SPO Y 48	0.4	5.6			-	227	-	494			85.001		0.6
3SE69	A03	SPO Y 48	0.9		2.0							606			
16OC69	IMU	S/N 48	SHIPPED TO FSC												
18NO69	IMU	S/N 48	RETURNED TO AC/MKE.												
20NO69	A01	SPO Y 48	2.2		8.1										
21NO69	A01	SPO Y 48	1.7	0.4				174	-	240	C110		85.021		1.4
21NO69	A01	SPO Y 48									C114	682			
21NO69	MILLIWATT	IS LESS THAN 2 MW.	THROUGHOUT.												
5FE70	A03	SPO Y 48	0.9		- 9.8										
5FE70	A03	SPO Y 48	1.5		- 7.7										
6FE70	A03	SPO Y 48	2.7		- 9.5										
6FE70	A03	SPO Y 48	2.3	0.7	- 160	-	528						85.016		0.0
12FE70	NO	FLUID	TRANSIENTS APPARENT	IN	GRAVITY	TRANSIENT	TEST.								
16FE70	DATA	AFTER	WEEKEND	STOPPAGE	WITH	Y SSA	UP	FOLLOWS	(DIAG.	381).					
16FE70	A03	SCK Y 48	2.5		- 8.9										
17FE70	DATA	AFTER	OVERTIGHT	STOPPAGE	WITH	Y SPA	DOWN	FOLLOWS.							

SA-117 CONTINUED

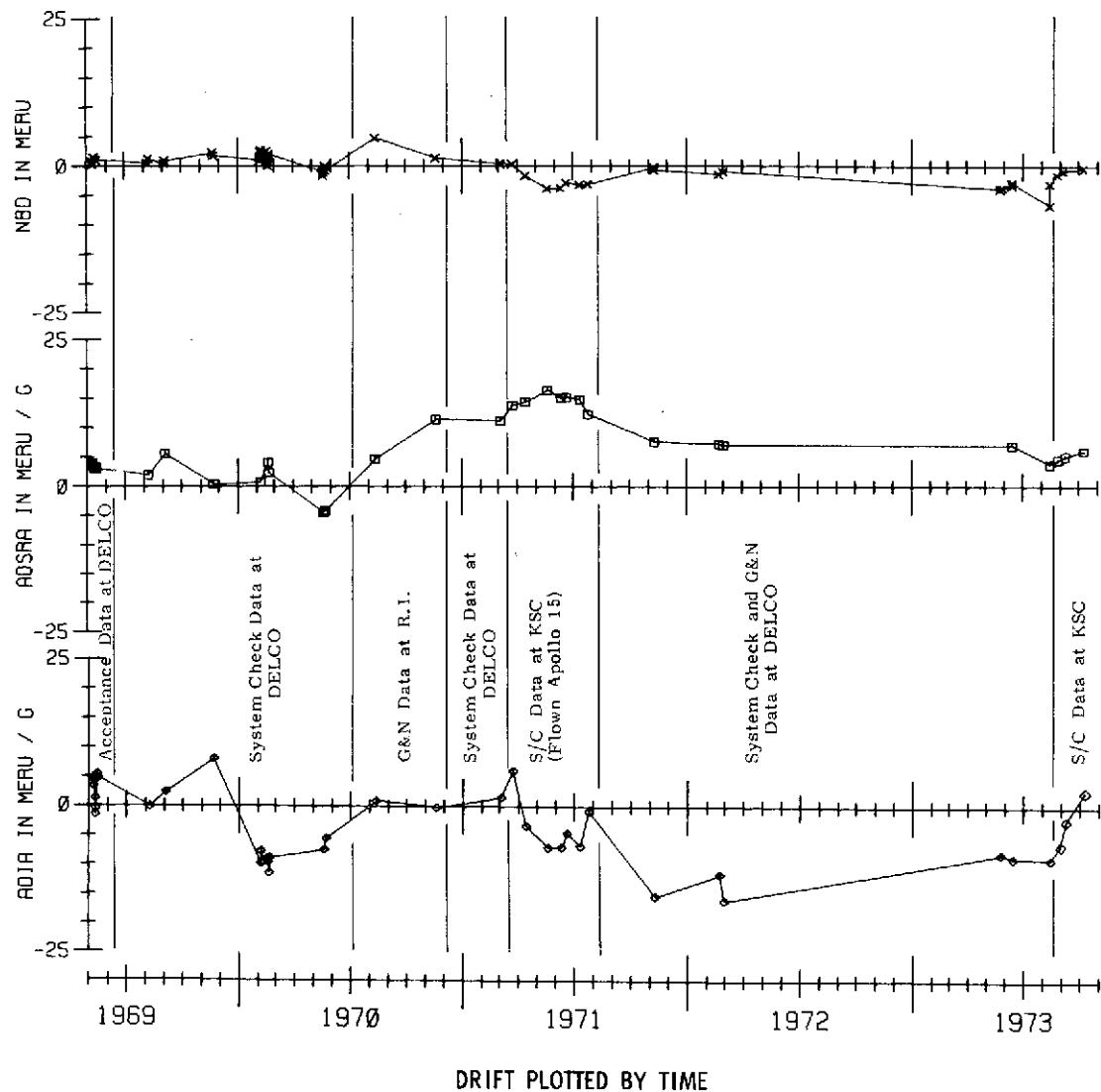
NASA 8A-117

DATE	TST	IMU	GEN	LOC	TYP	ASSN	SYS	NBB	ADSFA	ADTA	DELSF+ DELSF-	WHEEL			I+	I-	ID	ADOA		
												PDT	HOURS	T+						
17FE70	A03	SCK	Y 48								- 9.5									
18FE70	DATA AFTER OVERNIGHT STORAGE WITH Y IA UP FOLLOWS.																			
18FE70	A03	SCK	Y 48							0.0	- 4.1							1.3		
18FE70	A03	SCK	Y 48							0.7	- 11.4									
19FE70	DATA AFTER OVERNIGHT STORAGE WITH Y IA DOWN FOLLOWS.																			
19FE70	A03	SCK	Y 48							1.5	- 2.3							1.3		
19FE70	A03	SCK	Y 48							1.9	- 8.8									
16MP70	IMU S/N 48 SHIPPED FROM AC/MKE TO KSC.											811								
12MY70	IMU S/N 48 SHIPPED FROM KSC TO AC/MKE.																			
19MY70	A03	SPO	Y 48							- 1.1	- 7.4									
19MY70	A03	SPO	Y 48							- 1.7	- 4.5	C113						1.1		
22MY70	A03	SPO	Y 48							- 0.1	- 5.5									
22MY70	A03	SPO	Y 48							- 0.8	- 4.2							1.1		
25MY70	A03	SPO	Y 48								- 294 - 674									
27MY70	NO FLUID TRANSIENTS APPARENT DURING GRAVITY TRANSIENT TEST.											916 85.003								
7JL70	IMU S/N 48 SHIPPED FROM AC/MKE TO NR.																			
13JL70	IMU S/N 48 INSTALLED IN CM-112 (GEN 217).																			
11AU70	NSC	GEN	Y 48 217					4.7	4.7	0.9	- 15 - 485									
11AU70	ADIAY POSITION 8											- 7.0								
31AU70	NSC	GEN	Y 48 217								990									
31OC70	NSC	GEN	Y 48 217								995									
18NO70	NSC	GEN	Y 48 217					1.3	11.4	- 0.2	- 130 - 348									
18NO70	ADIAY POSITION 8											- 4.3								
7DE70												1150								
9DE70	IMU S/N 48 SHIPPED FROM NR TO DELCO/MKE.																			
28FE71												1174								
4MR71	A03	SPO	Y 48					0.3		1.6										
4MP71	A03	SPO	Y 48					0.5	11.2											
5MP71	A03	SPO	Y 48							- 160 - 407		85.016						1.6		
7MR71	NO FLUID TRANSIENTS DETECTED DURING GRAVITY TRANSIENT TEST.																			
8MR71												1265								
8MR71	IMU S/N 48 SHIPPED FROM DELCO/MKE TO KSC.																			
19MR71	IMU 48 GEN 217 INSTALLED IN CM-112.																			
23MR71	KOB	GEN	Y 48 217					0.3	13.8	6.1	- 195 - 200							1.1		
23MR71	ADIAY POSITION 8											1.1								
31MR71	KOB	GEN	Y 48									1286								
13AP71	KOB	GEN	Y 48 217					- 1.7	14.4	- 3.3	- 172 - 114							1.1		
13AP71	ADIAY POSITION 8											1.5								
30AP71												1341								
19MY71	K9A	GEN	Y 48 217					- 3.9	16.4	- 7.0							1.2			
19MY71	ADIAY POSITION 8											- 1.0								
31MY71	K9A	GEN	Y 48									1416								
10JE71	K9A	GEN	Y 48 217					- 3.8	15.1	- 6.9							1.1			
10JE71	ADIAY POSITION 8											- 1.3								
19JE71	K9A	GEN	Y 48 217					- 2.9	15.2	- 4.5							1.2			
19JE71	ADIAY POSITION 8											- 1.6								
30JE71	K9A	GEN	Y 48									1521								
11JL71	K9A	GEN	Y 48 217					- 3.2	14.8	- 6.8							1.0			
11JL71	ADIAY POSITION 8											- 0.3								

8A-117 CONTINUED

VASA BA-117

G & N 222, CM 118, IMU 34, APOLLO IRIG 8A117, X AXIS



NASA BA-102

DATE	LOC	TYP	ASSN	SYS	RBD	ADSEA	ADIA	DELSF+	DELSF-	WHEEL				ADOA
										PDT	HOURS	I+	I-	
3NO68	SG	83.6,	70.2,	56.2	TG	58.4,	70.9,	86.6		REF H5201				
4NO68	A42	CSS				(-	4.5)	(-	1.7)	(-	2.3)		C103	
4NO68	A42	CSS				(-	5.9)	(-	0.3)	(-	6.1)		C102	-15.2
11NO68	A45	CSS				(-	5.6)	(-	0.3)	(-	5.4)		148	-16.6
14NO68	A45	CSS									141		-15.9	
19NO68	COMP.	SELECT												
19NO68	A44	CSS							417	112	133	85.005	85.006	
20NO68	A44	CSS									142			
20NO68	A44	CSS									146			
26NO68	COMP	VESIF	TM	+ OOS										
26NO68	A44	CSS							-	725	160	85.002	85.004	
26NO68	DEMO		T/F	= 1213										
26NO68	A44	CSS							-	225		84.997	84.997	
27NO68	A44	CSS									152			
											141			
4DE68	VIB	IA ALIGN	= +0.1											
5DE68	A44	CA1				-	2.1	-	1.5	-	9.4			
5DE68	A44	CA2				-	2.6	-	1.0	-	9.0	+	62	
5DE68	A44	CA3				-	2.2	-	0.9	-	10.5		95	
8DE68	A44	CB1				-	1.9	-	1.3	-	10.6			
8DE68	A44	CB2				-	1.9	-	1.3	-	10.6	-	111	
8DE68	A44	CB3				-	1.9	-	1.5	-	9.1		341	
9DE68	A44	CC1				-	0.6	-	2.7	-	8.7			
10DE68	A44	CC2				-	1.7	-	2.7	-	7.4	-	159	
10DE68	A44	CC3				-	1.8	-	2.8	-	5.9		163	
11DE68	A42	CRT									150			
12DE68	A44	CRT									137			
											153		514	
14JA69	ACCEPTED	ON WAIVERS	C1241, C1234 & R1412											
			UNIT INSTALLED IN	IMU S/N 39Y, REPLACING	7A-200									
28JA69	A17	SPO Y 39		0.6	0.7		-	284	217		85.006		1.6	
28JA69	A17	SPO Y 39		1.0			-	7.9						
30JA69	A17	SCK Y 39		-	0.4	-	0.1						1.3	
30JA69	A17	SCK Y 39		+	0.4			-	8.7					
10FE69	A17	GEN Y 39		-	2.1	-	0.6	-	8.6	-	264	148		
10FE69	A17	GEN Y 39		-	1.3									
10FE69	A17	GEN Y 39		-	1.5								659	
26FE69	IND	S/N 39	SHIPPED TO GAEC											
6MR69	G20	GEN Y 39 613		-	1.5	-	0.6	-	5.6	-	333	206	684	
23Y69	G20	GEN Y 39 613		-	2.8	-	5.6	-	17.6	-	249	208	694	
13AU69	GSC	GEN Y 39 613		-	3.7	-	1.1	0.2	-	119		198		
13AU69	GSC	GEN Y 39 613		-	4.9				4.6					
13AU69	GSC	GEN Y 39 613		-	5.1				9.5				756	
13AU69	POSITION 8	ADIAY	= -10.66											
25OC69	GSC	GEN Y 39 613		-	5.7	-	0.7	-	0.7	-	142	160	823	
25OC69	ADIA POSITION 8	= -10.6												
3DE69	GSC	GEN Y 39 613		-	4.4	-	0.3	-	3.1	-	198	322	880	
3DE69	ADIAY POSITION 8								-	5.7				
31MR70	GSC	GEN Y 39 613											922	
3OAP70	GSC	GEN Y 39 613											942	
7MY70	TMU	S/N 39	SHIPPED FROM GAEC TO AC/MKE.											

BA-102 CONTINUED

NASA RA-102

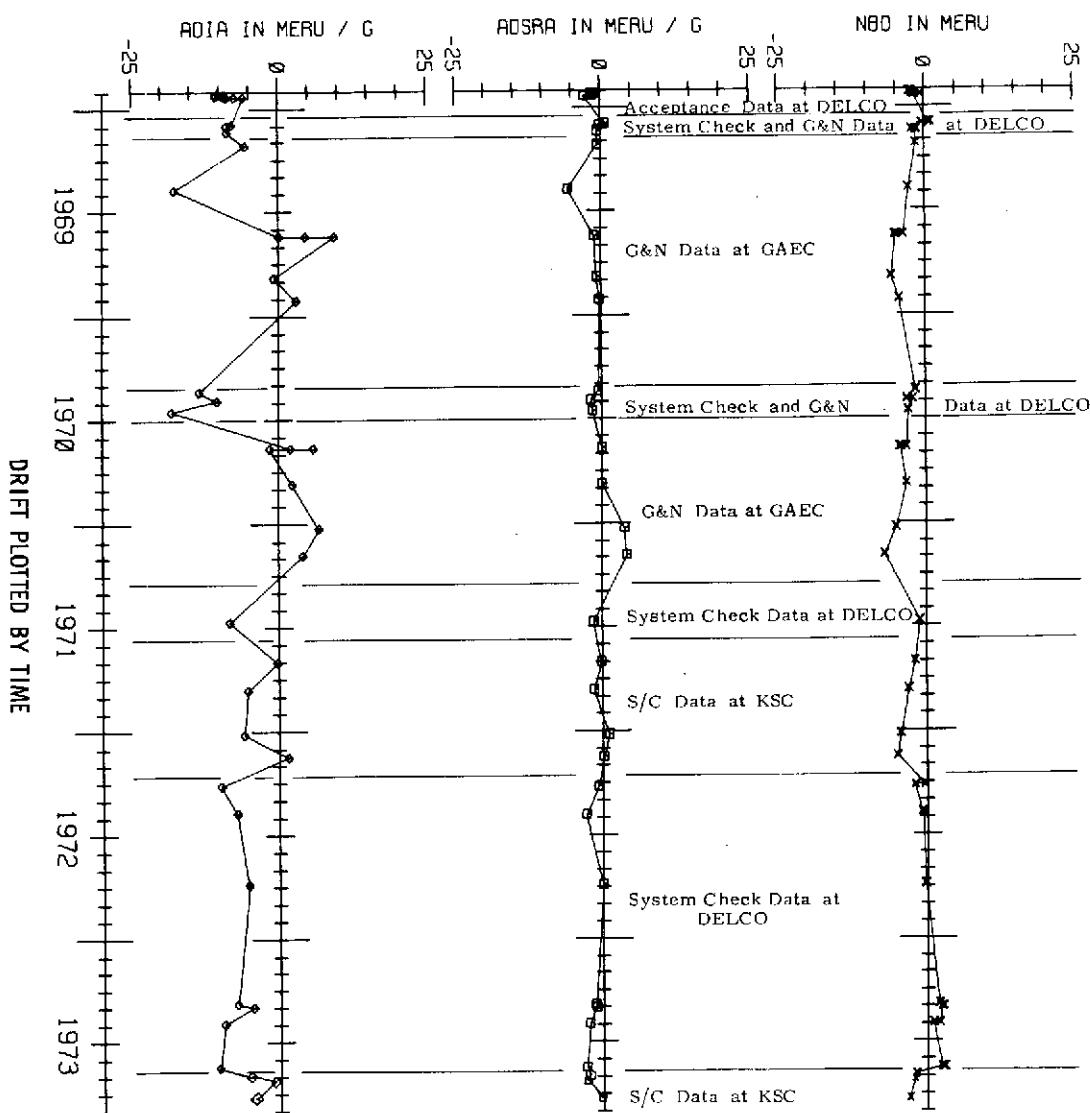
DATE	TST	IMU	G&N	LOC	TYP	ASSN	SYS	NBD	ADSFA	ADIAY	WHEEL		I+	I-	ID	ADON	
											DELSF+	DELSF-					RDT HOURS
12MY70	A05	SCK	Y 39					-	1.7	-	13.4						
12MY70	A05	SCK	Y 39					-	1.8	-	0.5	C111				1.7	
12MY70	A05	SCK	Y 39									C108	973				
12MY70	NO FLUID TRANSIENTS DETECTED DURING GRAVITY TRANSIENT TEST.																
28MY70	A07	SPO	Y 39					-	3.2	-	10.4						
28MY70	A07	SPO	Y 39					-	2.2	-	1.8	C110	1016			1.2	
1JE70	A07	SPO	Y 39									+ 484	60				
12JE70	A07	G&N	Y 39 615					-	3.0	-	1.5	-	18.1				
16JE70	A07	G&N	Y 39 615					-		-		-	571	-	35		
24JE70	IMU S/N 39 SHIPPED FROM AC/MKE TO GAC.																
15JL70	IMU S/N 39 INSTALLED IN LM-11 (G&N 615).																
20AU70	GSC	G&N	Y 39 615					-	3.3	0.1	2.0	-	315	261			
20AU70	ADIAY POSITION 8																
20AU70	GSC	G&N	Y 39 615					-	4.4			-	9.4				
20AU70	ADIAY POSITION 8																
20AU70	GSC	G&N	Y 39 615					-	4.2			-	10.0				
20AU70	ADIAY POSITION 8																
20AU70	GSC	G&N	Y 39 615					-				-	1.5				
20AU70	ADIAY POSITION 8																
31AU70	GSC	G&N	Y 39 615										1156				
31AU70	GSC	G&N	Y 39 615										1177				
22OC70	GSC	G&N	Y 39 615					-	3.3	0.1	2.3	-	264	114			
22OC70	ADIAY POSITION 8																
31OC70	GSC	G&N	Y 39 615											1231			
30NO70	GSC	G&N	Y 39 615												1239		
BJA71	GSC	G&N	Y 39 615					-	5.1	3.8	6.8	-	294	84			
BJA71	ADIAY POSITION 8																
31JA71	GSC	G&N	Y 39 615					-				-	9.4				
24FE71	GSC	G&N	Y 39 615					-	7.0	4.2	4.1	-	259	186			
24FE71	ADIAY POSITION 8																
28FE71	GSC	G&N	Y 39 615												1343		
31MR71	GSC	G&N	Y 39 615												1355		
11AP71	GSC	G&N	Y 39 615												1377		
22AP71	IMU S/N 39 SHIPPED FROM GAC TO DELCO/MKE.																
21JE71	A07	SPO	Y 39					-	1.1	-	8.3						
21JE71	A07	SPO	Y 39					-	1.2	-	1.5						
22JE71	A07	SPO	Y 39									- 461	50 C114	85.006		1.0	
25JE71	NO FLUID TRANSIENTS DETECTED DURING GRAVITY TRANSIENT TEST.																
27JL71	IMU 39 SHIPPED FROM DELCO/MKE TO KSC.																
11AU71	IMU 39 INSTALLED IN LM-11																
31AU71	KOB	G&N	Y 39 615					-	2.0	-	0.2	-	0.2	-	530	44	
31AU71	ADIAY POSITION 8																
19OC71	KOB	G&N	Y 39 615					-	3.1	-	1.4	-	5.3			1.6	
19OC71	ADIAY POSITION 8																
6JA72	K9A	G&N	Y 39 615					-	4.4	1.1	5.9	-	432	181		1.4	
6JA72	ADIAY POSITION 8																
14FE72	K9A	G&N	Y 39 615					-	5.0	0.2	1.6					2.3	
14FE72	ADIAY POSITION 8																
29FE72															1668		
22MR72	IMU S/N 39 REMOVED FROM LM-11 DUE TO BAD Y-PIPE.																
23MP72	IMU S/N 39 SHIPPED FROM KSC TO DELCO/MKE.																

8A-102 CONTINUED

NASA BA-102

DATE	TST	IMU	GEN	NSD	ADSEA	ADIAY	DELSF+	DELSF-	WHEFL			I+	I-	ID	ADDA			
									BOT	HOURS								
5AP72	A07	SPO	Y 39	-	0.4	-	9.0	-										
6AP72	A07	SPO	Y 39	-	2.0	-	0.7	-	407	60					85.005			
22MY72	A07	SPO	Y 39	-	0.8	-		-	7.1									
25MY72	A07	SPO	Y 39	-	0.6	-	2.8	-	407	7					85.006			
26SE72	SB6	SPO	Y 39	-	0.3	-		-	5.2									
26SE72	SB6	SPO	Y 39	-	0.2	-	0.0	-	397	195					85.000			
26SE72 NO FLUID TRANSIENTS DETECTED DURING GRAVITY TEST.																		
10JA73	UNIT REMOVED FROM IMU-39.																	
10JA73	UNIT ASSIGNED TO IMU-34, Y-POS. REPLACES 7C033.																	
10JA73															2078			
12AP73	SB6	SPO	Y 34	-		-		-	751	-	202				84.999			
24AP73	SB6	SPO	Y 34	-	2.0	-	7.2											
25AP73	SB6	SPO	Y 34	-	2.0	-	1.3								0.3			
25AP73 NO FLUID TRANSIENTS DETECTED DURING GRAVITY TEST.																		
30AP73															2203			
30AP73	SB6	SPO	Y 34	-	2.7	-	4.5											
30AP73	SB6	SPO	Y 34	-	2.4	-	1.2					C114						
29MY73	SB6	SPO	Y 34	-	2.0	-	9.4					C116						
29MY73	SB6	SPO	Y 34	-	1.0	-	2.3	-	673	-	228	C113			85.000			
30JU73															2363			
13AU73	SB6	SPO	Y 34	-		-		-	594	-	135				85.000			
14AU73	SB6	SPO	Y 34	-	2.5	-	10.3					C115						
15AU73	SB6	SPO	Y 34	-	2.9	-	2.9											
21AU73	IMU-34 SHIPPED FROM DELCO TO KSC.																	
24AU73	IMU-34 INSTALLED IN CM-118 (SKYLAB-4).																	
28AU73	K9B	GEN	Y 34 222	-	1.4	-	2.7	-	4.4	-	770	-	272		2.0			
28AU73	ADIAY POSITION-A																	
4SE73	K9B	GEN	Y 34 222	-	1.8	-	2.9	-	1.3						1.7			
4SE73	ADIAY POSITION-B																	
10OC73	K9B	GEN	Y 34 222	-	2.9	-	0.2	-	3.9						2.1			
10OC73	ADIAY POSITION-A																	

G & N 222, CM 118, IMU 34, APOLLO IRIG 8A102, Y AXIS



NASA 8A-101

TST	IMU	G&N													
DATE	LOC	TYPE	ASSN	SYS	VBD	ADSPA	ADIA	DELSF+	DELSF-	WHEEL	RDT HOURS	I+	I-	ID	ADOA
19NO68	SG	84.2,	69.0,	57.3	TG	54.7,	68.8,	32.2		SEP H5202					
20NO68	A41	CSS				(10.7)	(- 0.4)	(- 3.7)		C104					
25NO68	A43	CSS				(14.3)	(- 2.4)	(- 0.5)		C105					
28NO68	A42	CSS				(18.1)	(- 1.1)	(- 6.6)		139					
28NO68	BANK #2	CSS	006	- UNIT DEGAUSSSED & CSS PERIOD						131					
29NO68	A42	CSS				(12.6)	(- 3.7)	(- 0.8)		130					
30NO68	A42	CSS				(11.1)	(- 3.0)	(- 2.7)		126					
3DE68	A42	CSS								128					
9DE68	COMP	SELECT													
9DE68	A42	CSS								72	369	135	85.002	85.002	
10DE68	COMP	VERIFY								-	783	232	85.002	85.003	
10DE68	A42	CSS													
10DE68	DEMO		T/F =	1196.33											
10DE68	A42	CSS									44	324	137	85.002	85.002
10DE68	VIB	IA ALIGN	=	-0.5											
12DE68	A45	CA1				- 1.7	2.9	0.0							
12DE68	A45	CA2				- 1.7	2.9	0.7	144	314					
12DE68	A45	CA3				- 1.7	2.9	- 1.3		138					
15DE68	A45	CB1				- 0.9	3.1	- 3.5							
15DE68	A45	CB2				0.1	3.0	- 6.1	131	327					
15DE68	A45	CB3				- 0.3	2.5	- 5.0		139					
18DE68	A44	CC1				1.5	3.5	- 3.4							
18DE68	A44	CC2				2.7	3.4	- 6.0	93	317					
18DE68	A44	CC3				1.6	3.4	- 3.4		138	523		84.989	84.990	16.2
13JA69	ACCEPTED	ON WAIVERS	E1415	&	C1231	REV.	1								
	UNIT	INSTALLED	IN	IMU	S/N	397,	REPLACING	7A-135							
28JA69	A17	SPO Z	39		2.6	10.2			451	50			85.007		1.0
28JA69	A17	SPO Z	39		3.2		-	15.0							
30JA69	A17	SCK Z	39		2.3	10.3									1.1
30JA69	A17	SCK Z	39		2.8		-	15.5							
10FE69	A17	G&N Z	39		3.7	8.0	-	13.3	242	13			613		
10FE69	A17	G&N Z	39		3.2										
10FE69	A17	G&N Z	39		4.0								668		
26FE69	IMU	S/N	39	SHIPPED	TO	G&C									
6MR69	G20	G&N	Z	39	613	1.7	6.4	- 14.4	107	-	38		692		
23AU69	G20	G&N	Z	39	613	2.3	13.9	- 20.3	200	216			703		
13AU69	GSC	G&N	Z	39	613	4.3	1.6	- 11.8	320	94			765		
25OC69	GSC	G&N	Z	39	613	4.6	-	0.7	- 10.4	363	206			832	
3DE69	GSC	G&N	Z	39	613	4.9	-	1.6	- 8.2	231	104			889	
31MR70	GSC	G&N	Z	39	613									935	
30AP70	GSC	G&N	Z	39	613									955	
7MY70	IMU	S/N	39	SHIPPED	FROM	G&C	TO	AC/MKE.							
12MY70	A05	SCK Z	39		3.7		-	11.4							
13MY70	A05	SCK Z	39		4.5		5.6						C104		1.8
13MY70	A05	SCK Z	39										C109		
13MY70	A05	SCK Z	39										C107	986	
13MY70	NO	FLUID	TRANSIENTS	DETECTED	DURING	GRAVITY	TRANSIENT	TEST.							
28MY70	A07	SPO Z	39		3.0		-	14.3					C105	1029	
1JE70	A07	SPO Z	39												

NASA 8A-101

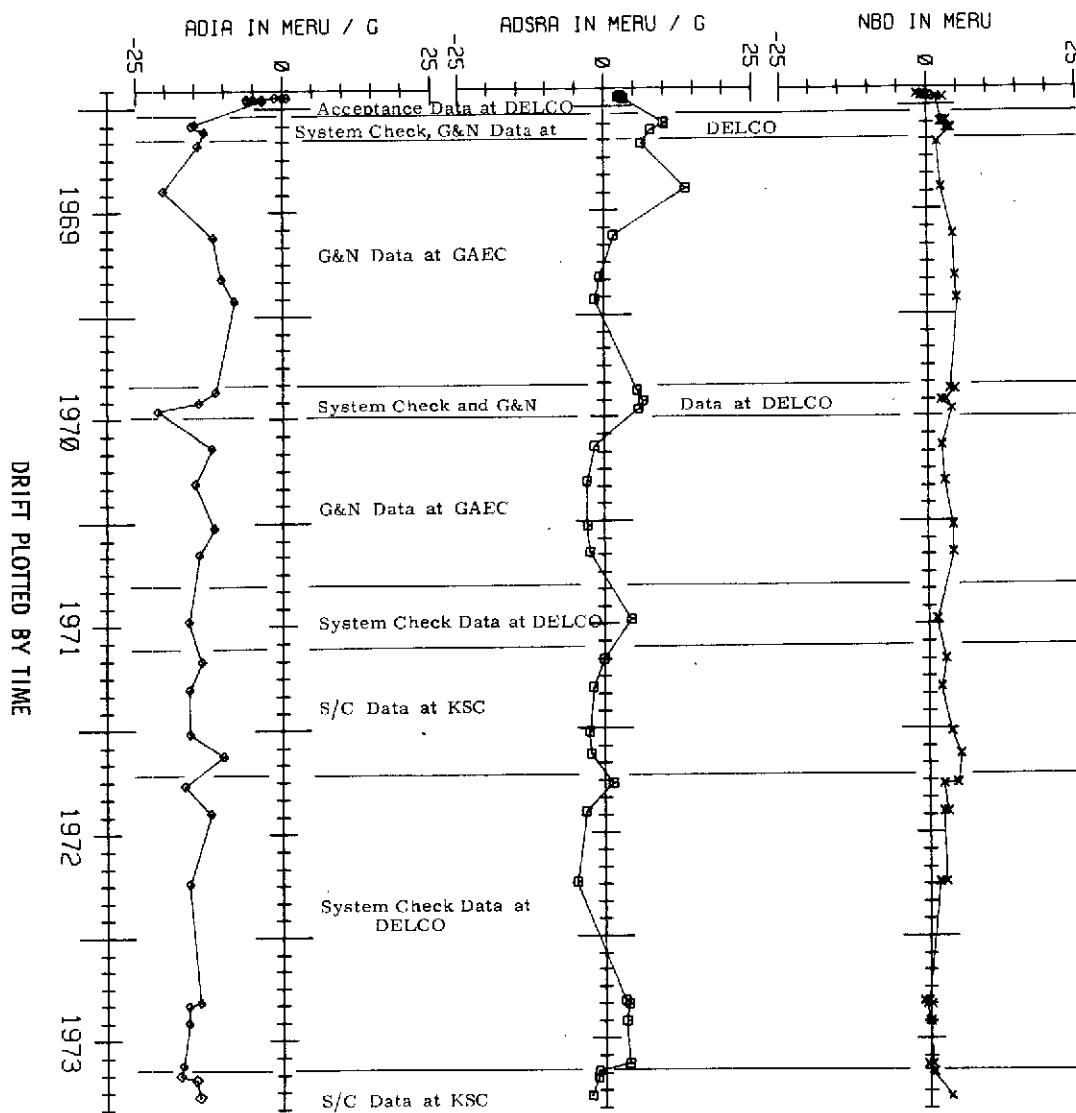
DATE	TST	IMU	GEN	ASSN	SYS	NSD	ADSEA	ADIA	DELSF+	DELSF-	WHEEL			I+	I-	ID	ADOA
											PDT	HOURS					
13E70	A07	SPO	Z	39		2.2		6.6		384	-	60			85.007		1.2
12JF70	A07	GEN	Z	39	615					227	-	170					
16JE70	A07	GEN	Z	39	615		4.0		5.8	-	21.2				1126		
24JE70	IMU	S/N	39	SHIPPED	FROM AC/MKE TO GAC.												
15JL70	IMU	S/N	39	INSTALLED	IN LM-11 (GEN 615).												
20AU70	GSC	GEN	Z	39	615		2.3	-	1.7	-	12.0	341	73				
31AU70	GSC	GEN	Z	39	615										1168		
30SE70	GSC	GEN	Z	39	615										1190		
22OC70	GSC	GEN	Z	39	615		2.8	-	3.0	-	14.8	221	31			1244	
31OC70	GSC	GEN	Z	39	615										1252		
31NO70	GSC	GEN	Z	39	615												
8JA71	GSC	GEN	Z	39	615		4.2	-	2.9	-	11.6	338	38			1276	
31JA71	GSC	GEN	Z	39	615												
24FF71	GSC	GEN	Z	39	615		4.2	-	2.4	-	14.2	297	55			1356	
28FP71	GSC	GEN	Z	39	615										1368		
31MR71	GSC	GEN	Z	39	615										1390		
11AP71	GSC	GEN	Z	39	615												
22AP71	IMU	S/N	39	SHIPPED	FROM GAC TO DELCO/MKE.												
22JE71	A07	SPO	Z	39		1.5				-	15.9						1.7
22JE71	A07	SPO	Z	39		1.4		4.5		294	-	174	C113		85.006		
25JE71	NO	FLUID	TRANSIENTS	DETECTED	DURING GRAVITY TRANSIENT TEST.												
27JL71	IMU	S/N	39	SHIPPED	FROM DELCO/MKE TO KSC.												
11AU71	IMU	S/N	39	INSTALLED	IN LM-11												
31AU71	KOB	GEN	Z	39	615		2.9	-	0.1	-	13.7	-	66	244			1.5
19OC71	KOB	GEN	Z	39	615		2.1	-	1.9	-	15.8						1.6
6JA72	K9A	GEN	Z	39	615		3.8	-	2.6	-	15.7	116	513				1.4
14FE72	K9A	GEN	Z	39	615		5.3	-	2.3	-	10.0						1.2
29FE72														1681			
22MR72	IMU	S/N	39	REMOVED	FROM LM-11 DUE TO BAD Y-PIPA.												
23MP72	IMU	S/N	39	SHIPPED	FROM KSC TO DELCO/MKE.												
5AP72	A07	SPO	Z	39		4.7		1.4									
6AP72	A07	SPO	Z	39		2.4			-	16.6	361	40			85.005		
25MY72	A07	SPO	Z	39		3.1			-	12.2							
25MY72	A07	SPO	Z	39		2.4	-	3.2		394	40				85.006		
26SE72	SB6	SPO	Z	39		2.8			-	15.8							
26SE72	SB6	SPO	Z	39		1.6	-	4.8		594	140				85.000		
26SE72	NO	FLUID	TRANSIENTS	DETECTED	DURING GRAVITY TEST.												
10JA73	UNIT REMOVED	FROM IMU-39.															
10JA73	UNIT ASSIGNED	TO IMU-34, Z-POS.	REPLACES 7B189.														
10JA73														2092			
13AP73	SB6	SPO	Z	34						176	-	443			84.999		
25AP73	SB6	SPO	Z	34		-	0.3			-	14.0						- 1.8
25AP73	SB6	SPO	Z	34		-	1.1		3.4								
25AP73	NO	FLUID	TRANSIENTS	DETECTED	DURING GRAVITY TEST.												
30AP73														2217			
1MY73	SB6	SPO	Z	34		0.2			-	16.0							
1MY73	SB6	SPO	Z	34		-	0.6		3.9					C114			
31MY73	SB6	SPO	Z	34		-	0.2			-	16.0			C111			
31MY73	SB6	SPO	Z	34		0.1		3.5		135	-	187	C112		85.000		- 2.2
30JE73														2377			

8A-101 CONTINUED

NASA 8A-101

DATE	LOC	TYP	ASSN	GEN	SYS	KBD	ADSFA	ADIA	WHEEL		RDT HOURS	I+	I-	ID	ADON		
									DELSF+	DELSF-							
13AU73	SR6	SPO	Z 34						250	-	121	C115	84.998				
15AU73	SB6	SPO	Z 34							-	17.0						
15AU73	SR6	SPO	Z 34						-	0.4	4.1						
21AU73	IMU-34 SHIPPED FROM DELCO TO KSC.																
24AU73	IMU-34 INSTALLED IN CM-118 (SKYLAB-4).																
28AU73	K9B	GEN	Z 34	222			0.6	-	1.0	-	17.9	-	70	-	259	1.3	
4SE73	K9B	GEN	Z 34	222			1.5	-	1.1	-	14.0					1.4	
10OC73	K9B	GEN	Z 34	222			2.9	-	2.0	-	12.9					1.2	

G&N 222, CM 118, IMU 34, APOLLO 11 RIG 8A101, Z AXIS

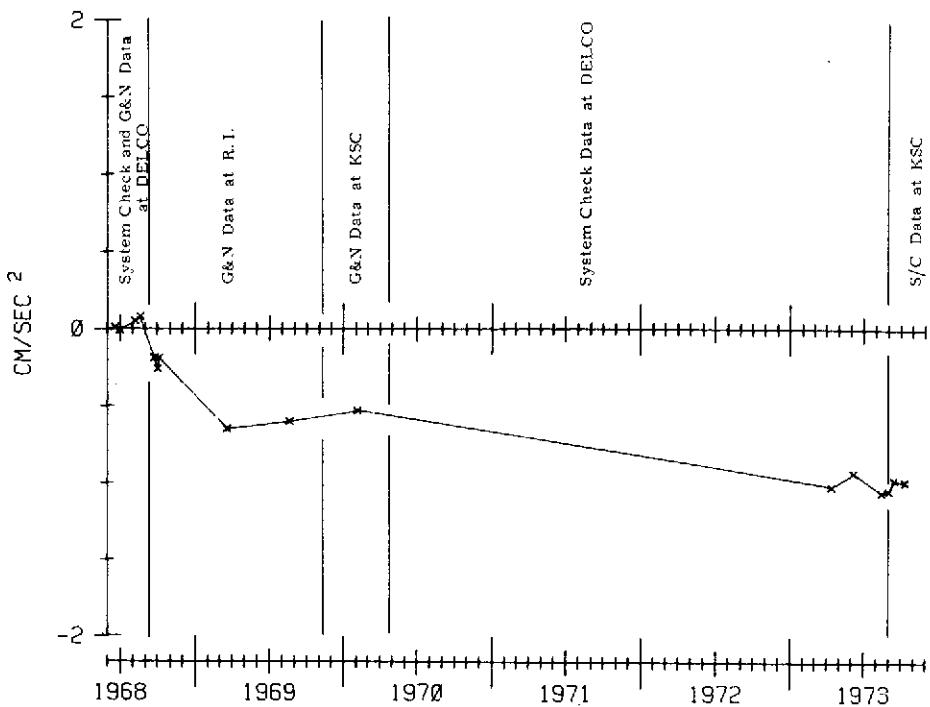


NASA SAP-333

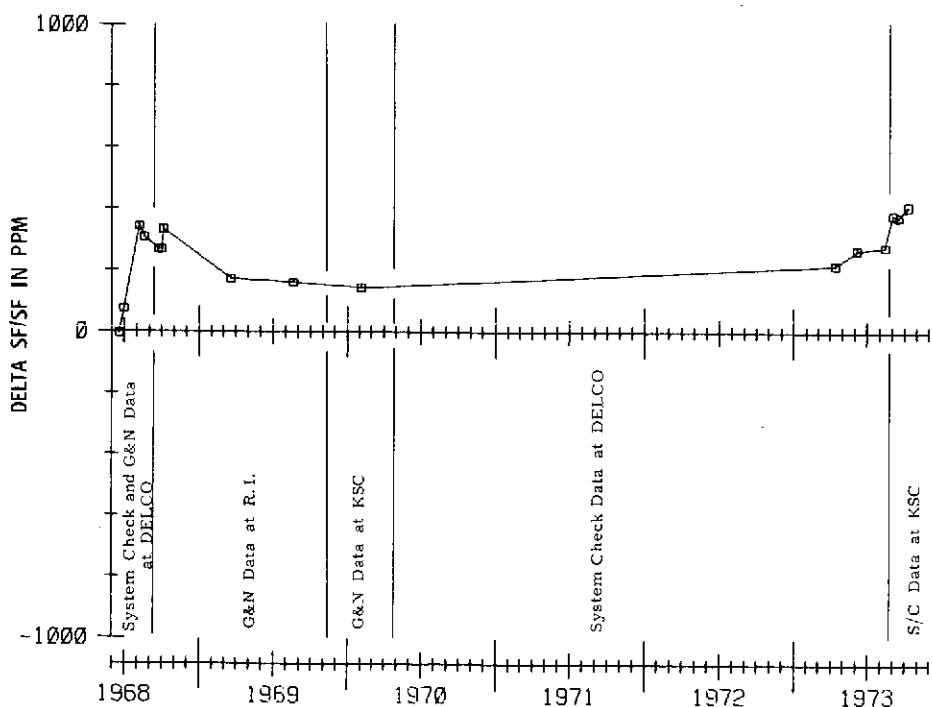
DATE	TST	IMU	G&N	DELTA	IG	NULL	ROT-AL-MOB	TORQ MCN		
	LOC	TYP	ASSN	SYS	SP	BIAS	BIAS	ANGLE	TRANS.	CURRENT
19JE67	S48	ACC			118		0.00			104.1125
13MY68	UNIT	ASSN	TO IMU	S/N 34	X					
5JE68	A03	SPR	X	34		(-458)	(0.27)	(0.64)		104.1100
9JE68	A03	SPR	X	34		(-117)	(-0.93)	(-0.93)		104.1077
18JE68	A03	SPR	X	34		- 4	0.01	0.03		104.1055
18JE68	AFTER DEGAUSSING AND ADJUSTMENT									
30JE68	A03	SPO	X	34		(-37)	(0.88)	(0.89)		104.1085
30JE68	D CRITERIA LIMITS EXCEEDED. PIP DEGAUSSSED									
30JE68	A03	SPO	X	34	75	-0.01	-0.02			104.1068
30JE68	A03	SAL	X	34			(0.01)	- 6	- 9	
31JL68	A03	SAL	X	34			(0.01)	- 11	- 34	
6AU68	A07	G&N	X	34	344	0.05				
15AU68	A03	SAL	X	34			(-0.19)	- 12	- 12	
19AU68	A07	G&N	X	34	308	0.08				
18SE68	IMU S/N 34 SHIPPED TO NR									
23SE68	N02	G&N	X	34	216	268	-0.19			
24SE68	N02	G&N	X	34	214			- 51	- 53	
10C68	N02	G&N	X	34	214	269	-0.26			
40C68	N02	G&N	X	34	214	334	-0.19			
19MR69	NSC	G&N	X	34	214	172	-0.65			
19AU69	NSC	G&N	X	34	214	160	-0.60			
17NO69	CM-110 SHIPPED TO KSC WITH IMU S/N 34, G&N 214 INSTALLED									
4FE70	K08	G&N	X	34	214	144	-0.53			
27AP70	IMU S/N 34 SHIPPED FROM KSC TO MKE									
13AP73	SB6	SPO	X	34	219	-1.02	-0.98	0.04	104.0964	
26AP73	SB6	SAL	X	34			(-0.88)	- 11	- 4	
26AP73	SB6	SAL	X	34			(-0.90)	- 18		
26AP73	SB6	SAL	X	34			(-0.92)	- 19		
6JE73	SB6	SPO	X	34	269	-0.93	-0.90	0.03	104.1003	
11JE73	SB6	SAL	X	34			(-0.89)	- 20	- 3	
16AU73	SB6	SPO	X	34	279	-1.06	-1.06	0.03	104.0963	
16AU73	SB6	SAL	X	34			(-1.04)	- 19	- 7	
21AU73	IMU-34 SHIPPED FROM DELCO TO KSC.									
24AU73	IMU-34 INSTALLED IN CM-118 (SKYLAB-4).									
28AU73	K9B	G&N	X	34	222	369	-1.03			
4SE73	K9B	G&N	X	34	222	363	-0.96			
10OC73	K9B	G&N	X	34	222	404	-0.98			

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G & N 222, CM 118, IMU 34, APOLLO PIPA 3AP333, X AXIS



1-G BIAS DRIFT PLOTTED BY TIME

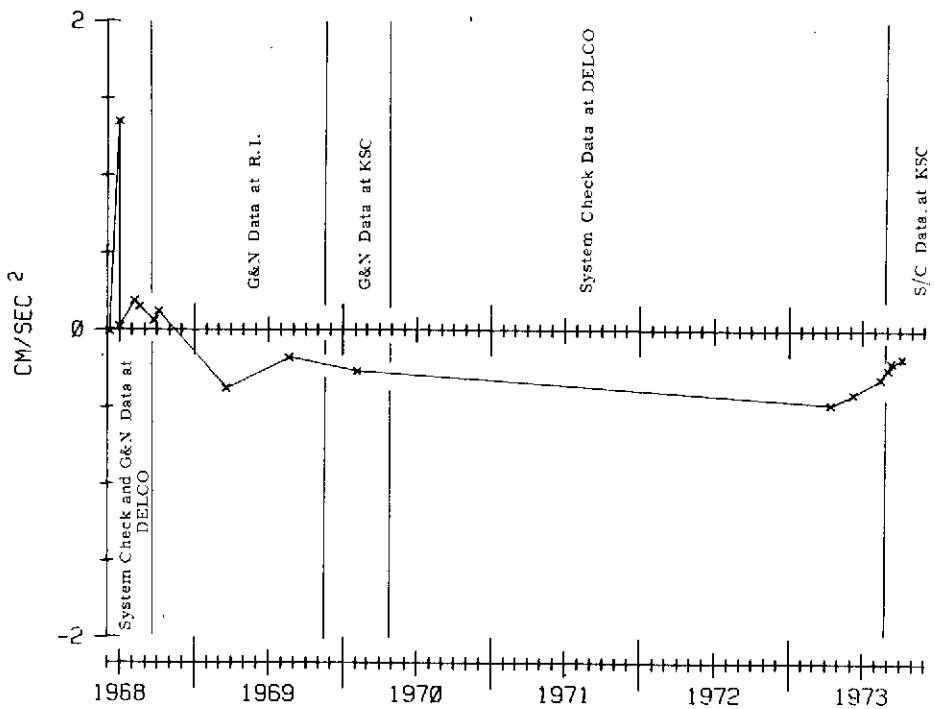


SCALE FACTOR DRIFT PLOTTED BY TIME

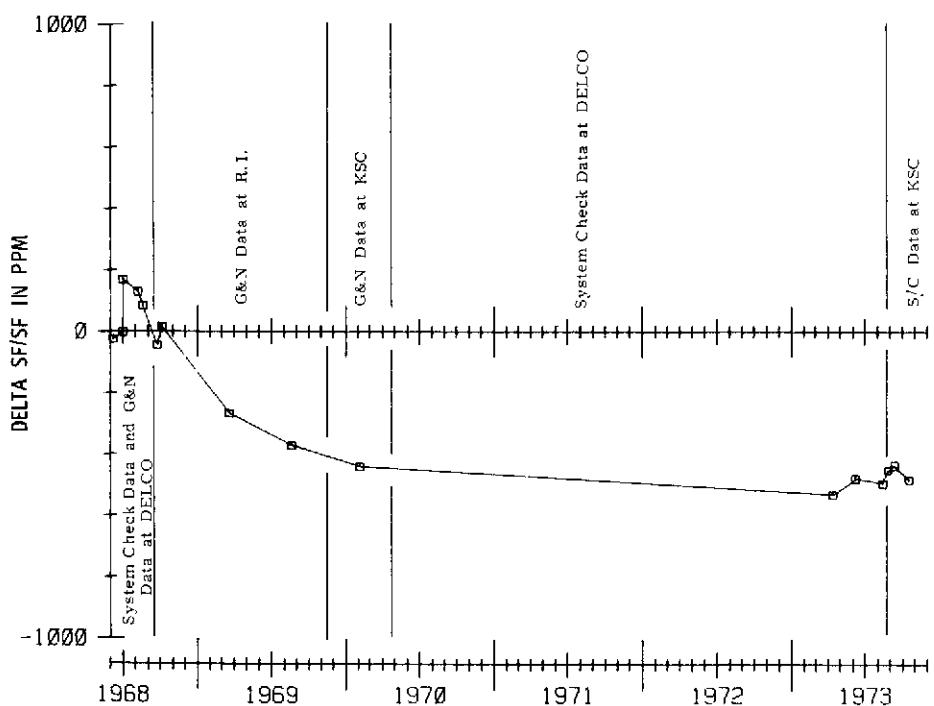
NASA SAP-334

DATE	TST	IMU	G&N	DELTA	IG	NULL	ROT-AL-WOB	TOEQ MON		
	LOC	TYPE	ASSN	SYS	SP	BIAS	BIAS	ANGLE	TRANS.	CURRENT
23JE67	S42	ACC			- 274		0.00			104.1810
13HY68	UNIT	ASSN TO IMU S/N 34 , Y								
5JE68	A03	SPR Y 34			(- 196)	(0.22)	(0.21)			104.2230
6JE68	A03	SPP Y 34			- 25	- 0.01	- 0.09			104.2283
6JE68	AFTER DEGAUSSING AND ADJUSTMENT									
30JE68	A03	SPO Y 34			- 2	1.35	1.30			104.2275
30JE68	D CRITERIA LIMITS EXCEEDED. PIP DEGAUSSSED									
30JE68	A03	SPO Y 34			168	0.02	- 0.01			104.2268
30JE68	A03	SAL Y 34				(-0.05)	-	6	23	
31JL68	A03	SAL Y 34				(0.03)		0	20	
6AU68	A07	G&N Y 34			129	0.19				
15AU68	A03	SAL Y 34				(-0.14)		1	26	
19AU68	A07	G&N Y 34			83	0.15				
18SE68	IMU	S/N 34 SHIPPED TO NR								
23SE68	N02	G&N Y 34 214			- 45	0.06				
24SE68	N02	GAL Y 34 214						17		
4OC68	N02	G&N Y 34 214			15	0.12				
19MR69	NSC	G&N Y 34 214			- 267	- 0.38				
19RU69	NSC	G&N Y 34 214			- 371	- 0.18				
17NO69	CM-110	SHIPPED TO KSC WITH IMU S/N 34, GEN 214 INSTALLED								
4PE70	K0B	G&N Y 34 214			- 439	- 0.27				
27AP70	IMU	S/N 34 SHIPPED FROM KSC TO MRE								
13AP73	SB6	SPO Y 34			- 531	- 0.48	- 0.49		0.03	104.2176
27AP73	SB6	SAL Y 34				(-0.51)		9	0	
7JE73	SB6	SPO Y 34			- 478	- 0.41	- 0.40		0.03	104.2201
12AE73	SB6	SAL Y 34				(-0.35)		7	26	
16AU73	SB6	SPO Y 34			- 494	- 0.31	- 0.32		0.05	104.2233
17AU73	SB6	SAL Y 34				(-0.33)		5	26	
21AU73	IMU-34	SHIPPED FROM DELCO TO KSC.								
20AU73	IMU-34	INSTALLED IN CM-118 (SKYLAB-4).								
28AU73	K9B	G&N Y 34 222			- 431	- 0.26				
4SE73	K9B	G&N Y 34 222			- 421	- 0.20				
10OC73	K9B	G&N Y 34 222			- 483	- 0.18				

G & N 222, CM 118, IMU 34, APOLLO PIPA 3AP334, Y AXIS



1-G BIAS DRIFT PLOTTED BY TIME

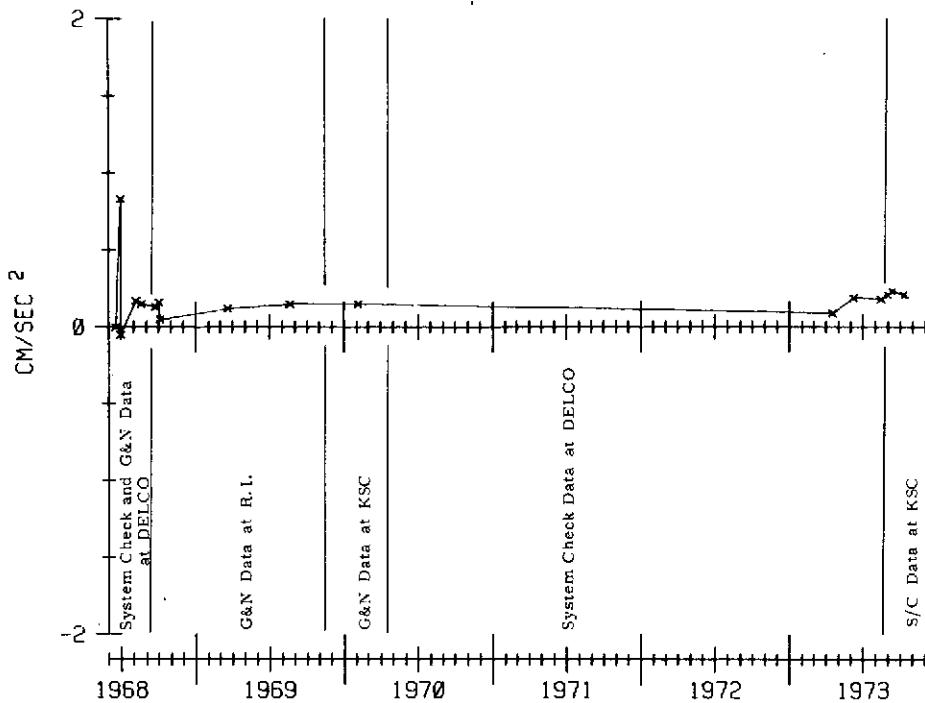


SCALE FACTOR DRIFT PLOTTED BY TIME

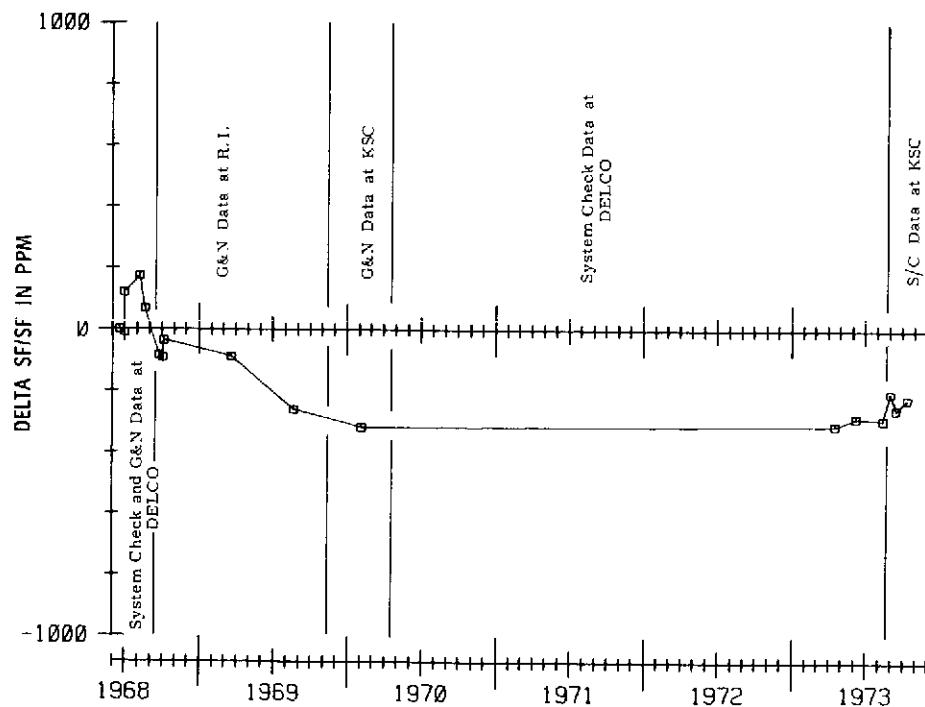
NASA JAP-335

DATE	TST	IMU	G&N	DELTA	IG	NULL	ROT-AL-WOB	TOBO MON
	LOC	TYP	ASSN	SYS	SP	BIAS	BIAS	CURRENT
13M768	UNIT ASSN TO IMU S/N 34	Z						
5J868	A03 SPR Z 34		(246)	(0.55)	(0.46)			104.0280
9JE68	RESELECT NULL/COINCIDENCE PESTSTOP							
9JE68	A03 SPP Z 34		(253)	(-1.14)	(-1.08)			104.0340
18J868	A03 SPR Z 34		0	-0.00	0.07			
18J868	AFTER DEGAUSSING AND ADJUSTMENT							
30J868	A03 SPO Z 34		- 10	0.83	0.86			104.0129
30J868	D CPTERIA LIMITS EXCEEDED. RIP DEGAUSSD							
30J868	A03 SPO Z 34		121	-0.05	-0.09			104.0130
30J868	A03 SAL Z 34				(-0.05)	- 32		
31JL68	A03 SAL Z 34				(0.28)	- 12		
6AU68	A07 G&N Z 34		175	0.17				
15AU68	A03 SAL Z 34				(0.25)	- 44		
19AU68	A07 GEN Z 34		68	0.15				
18SP68	IMU S/N 34 SHIPPED TO N?							
23S268	N02 GEN Z 34 214		- 84	0.13				
24SP68	N02 GAL Z 34 214				- 59	- 36		
10C68	N02 GEN Z 34 214		- 92	0.16				
40C68	N02 GEN Z 34 214		- 36	0.05				
19MR69	NSC GEN Z 34 214		- 88	0.12				
19AU69	NSC GEN Z 34 214		- 261	0.15				
17NO69	CM-110 SHIPPED TO KSC WITH IMU S/N 34, G&N 214 INSTALLED							
4F70	K08 GEN Z 34 214		- 318	0.15				
27AP70	IMU S/N 34 SHIPPED FROM KSC TO MKE							
16AP73	S86 SPO Z 34		- 309	0.09	0.08		0.05	104.0037
27AP73	S86 SAL Z 34				(-0.18)	- 18		
7JE73	S86 SPO Z 34		- 284	0.19	0.22		0.04	104.0068
12JE73	S86 SAL Z 34				(0.24)	- 17		
16A073	S86 SPO Z 34		- 291	0.18	0.22		0.03	104.0100
16AU73	S86 SAL Z 34				(0.26)	- 17		
21AU73	IMU-34 SHIPPED FROM DELCO TO KSC.							
24AU73	IMU-34 INSTALLED IN CM-118 (SKYLAB-4).							
28AU73	K9B GEN Z 34 222		- 205	0.20				
4SP73	K9B GEN Z 34 222		- 259	0.23				
10OC73	K9B GEN Z 34 222		- 234	0.21				

G&N 222, CM 118, IMU 34, APOLLO PIPA 3AP335, Z AXIS



I-G BIAS DRIFT PLOTTED BY TIME



SCALE FACTOR DRIFT PLOTTED BY TIME

**STANDARD DEVIATION (1σ) OF THE IRIG AND PIPA
PARAMETER UNCERTAINTIES USED FOR
MISSION PERFORMANCE SUMMARY
CM 118 IMU S/N 34**

PARAMETER

IMU Axis	<u>X</u>	<u>Y</u>	<u>Z</u>
PIPAs			
Data Compilation Period			
8/28/73 - 10/10/73			
Accelerometer Bias (cm/sec ²)	0.03	0.03	0.01
Scale Factor (SF/SF ppm)	5	8	22
IRIGs			
Data Compilation Period			
8/28/73 - 10/10/73			
Bias Drift (MERU)	0.4	0.6	0.9
ADSRA (MERU/g)	0.4	1.2	0.4
ADIA (MERU/g)	3.5	1.4	2.1
ADOA (MERU/g)	0.0	0.2	0.1

Data is based upon performance in the IMU. Point-to-point stability operation is much better than the above data.

**PROPOSED GYRO AND ACCELEROMETER
PERFORMANCE COMPENSATIONS**

PARAMETER

IMU Axis	<u>X</u>	<u>Y</u>	<u>Z</u>
PIPAs			
Accelerometer Bias (cm/sec ²)	-0.98	-0.18	+0.21
Scale Factor (SF/SF ppm)	+400	-480	-230
IRIGs			
Bias Drift (MERU)	-0.3*	-2.9	+2.9
ADSRA (MERU/g)	+5	0	-2
<u>ADIA (MERU/g)</u>	+2	-4	-13

* Compensation selected as NBD +.5

Dictionary of Terms

ACC	Acceptance Test Data
ACD	After Cooldown
ACE	A. C. Electronics (presently Delco Electronics)
ADJ	Adjusted
ADOA	Acceleration Sensitive Drift Due to Acceleration along the OA
BCSW	Binary Current Switch
BIA	Bias Adjusted
BUSS	High, Low, or Nominal Direct Current Test
CDN	Post Cooldown
CQL	Component Qualification
CRQ	Component Requalification
CRR	Retest after Minor Adjustment or Resistor Changes
CRT	Retest Data
CSS	Short Servo Test
CVR	Component Verification
DGI	Degaussed IRIG
DGS	Degaussed
F/F	Float Freedom
FST	Final Stability
GAL	Guidance & Navigation PIPA Alignment
G&N	Guidance & Navigation System Measurement
GP	Gauessed PIPAs
HBS	Hi Bus Voltage
I&A	Inspection and Acceptance
ISS	Inertial Subsystem Data
KSC	Kennedy Space Center
LBS	Lo Bus Voltage
MW	Milliwatt
NAR	North American Rockwell (presently Rockwell International, Inc.)
NBS	Nominal Bus Voltage
OOS	Out of Spec
RDT	Wheel Rundown Time, Seconds
RI	Rockwell International

APPENDIX

ELECTRICAL POWER REQUIREMENTS

This section was extracted from the MIT/IL Report E-1142 (Rev. 59) "SYSTEM STATUS REPORT". It is included in this report for convenience.

Electrical power and energy reporting is based upon the inflight spacecraft sequence of events for the Design Reference Mission as developed by the Apollo Mission Planning Task Force (AMPTF). (Reference GAEC Report Volume III - LED-540-12, dated October 30, 1964).

The accompanying diagrams present the power drawn through the spacecraft circuit breakers. It is assumed that power is drawn from the spacecraft's primary +28VDC supply and a 400 cps-115 VAC single-phase inverter.

Intermittent power peaks can exist, particularly during operation of displays and controls at random times. The energy content in these peaks is considered negligible.

All values (except those mentioned above) are actual expected levels of power at 28.0 VDC. They are based on measured values on G&N systems 207 and 208 for the Block II Command Module. No margin factor has been applied to protect against possible differences between G&N systems and spacecrafts. Thus, these values should not be taken as "not to exceed" extremes.

The following Interface Control Documents serve as the guidelines for reporting power figures.

CM Block II MH01-01327-216 "G&N Electrical Input Power" signed 15 July 1965.

BLOCK II GUIDANCE & NAVIGATION LOAD ON PRIMARY +28 VDC COMMAND MODULE

BASED UPON 198.5 HOURS (0.27 DAY) LUNAR ORBIT MISSION
DESIGN REFERENCE MISSION

STATUS OCTOBER 1967

REFERENCE GAFC REPORT - LED 540-12, 30 OCTOBER 1964
APOLLO MISSION PLANNING TASK FORCE

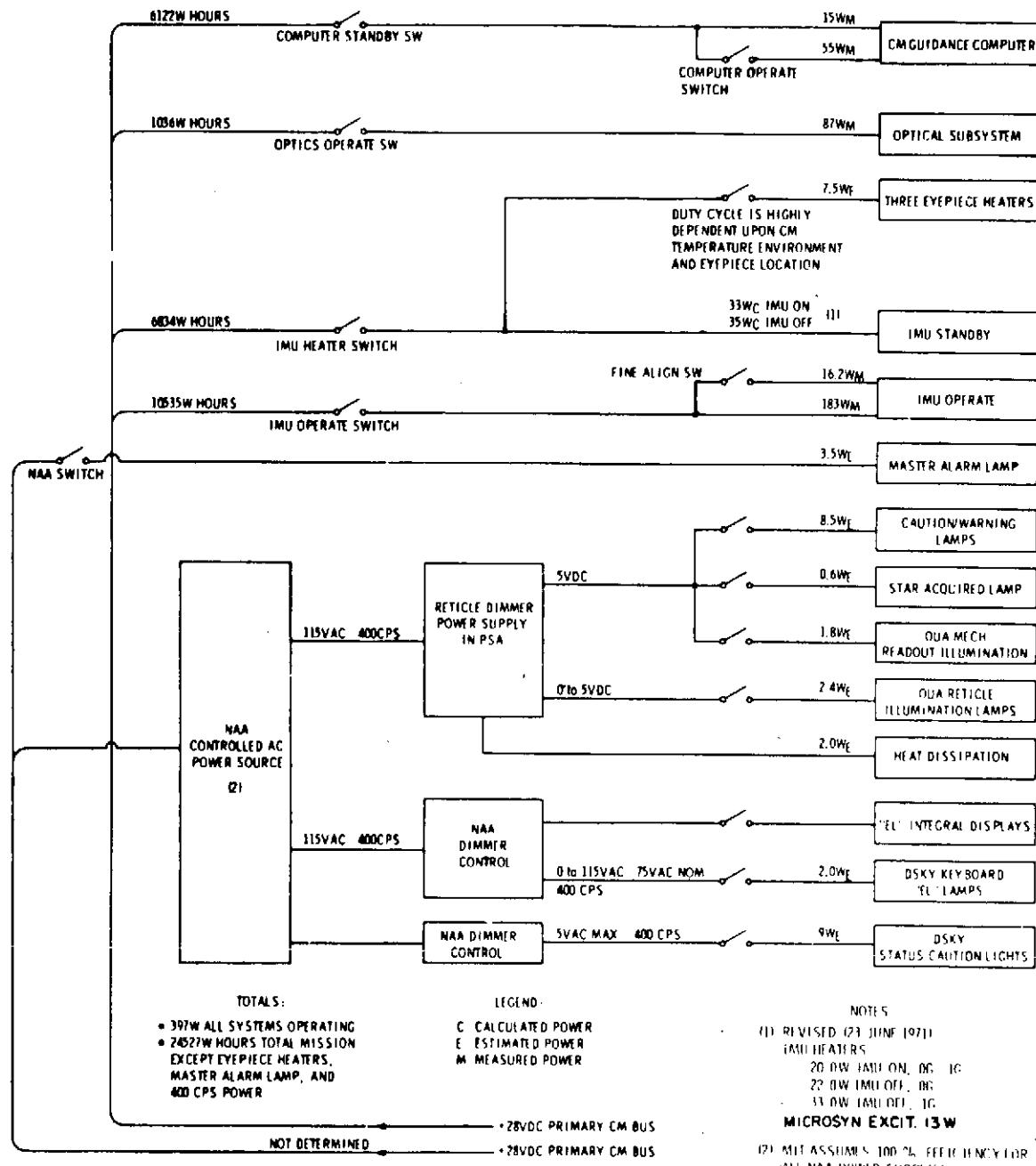


Figure A-1